

ICURS

Crime Pattern Visualization

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City Layers

The dimension layers frequently used in Environmental Criminology are displayed in Figure 1. These layers are:

- A street network;
- Transit infrastructure (bridges, public transit and private transit);
- Land uses (uses of land);
- Physical topography (bodies of water, mountains or steep hills, inaccessible areas); and,
- Social and economic characteristics of resident and ambient population.

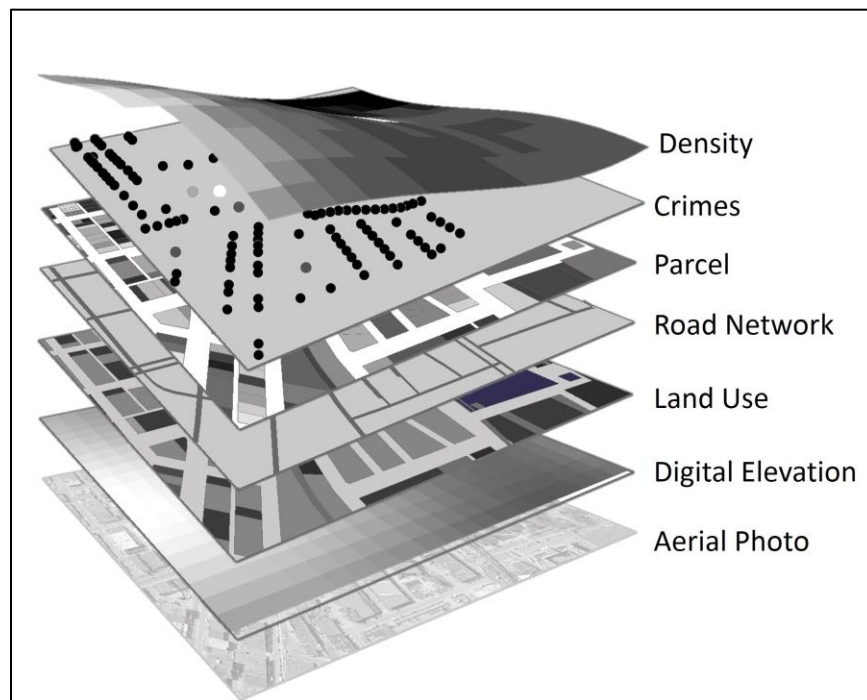


Figure 1: Environmental Criminology Dimension Layers

Street Network

Street networks are considered the backbone that shapes the city and central to understanding crime distribution. Older cities tend to have a historic part that has shorter streets whereas newer cities are car based and street segments are longer and less dense. Two of the older cities in Metro Vancouver are displayed in Figure 2 (Vancouver and New Westminster). The road segments in these city centres are shorter than the newer city centre of Langley.

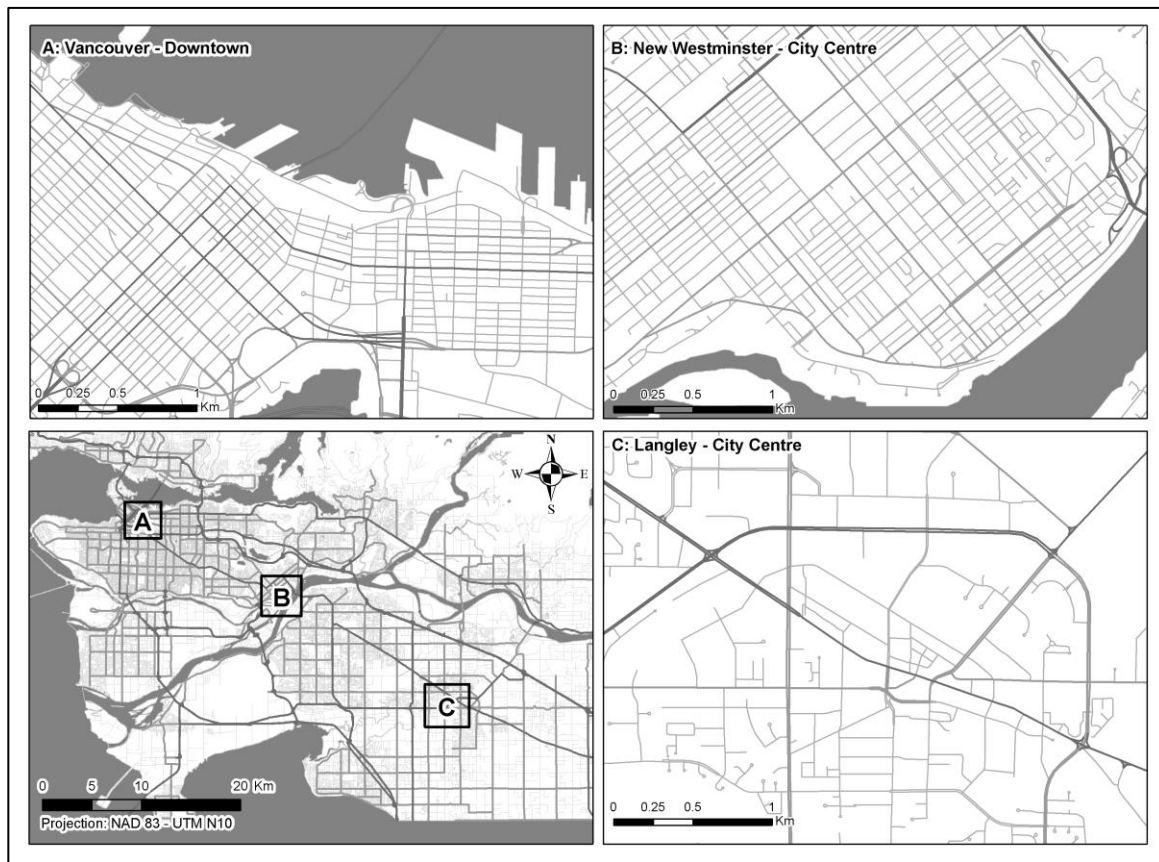


Figure 2: Metro Vancouver – Three City Centres Comparison

Street Network and Graph Theory

The street network creates structure, traffic volume and connectedness within the city structure. The classes of streets describe both the potential volume for human movement and the level of connectivity within a city. In Figure 3 the various streets are displayed and the variation of structure is apparent from the denser areas at the city centre to more residential areas.

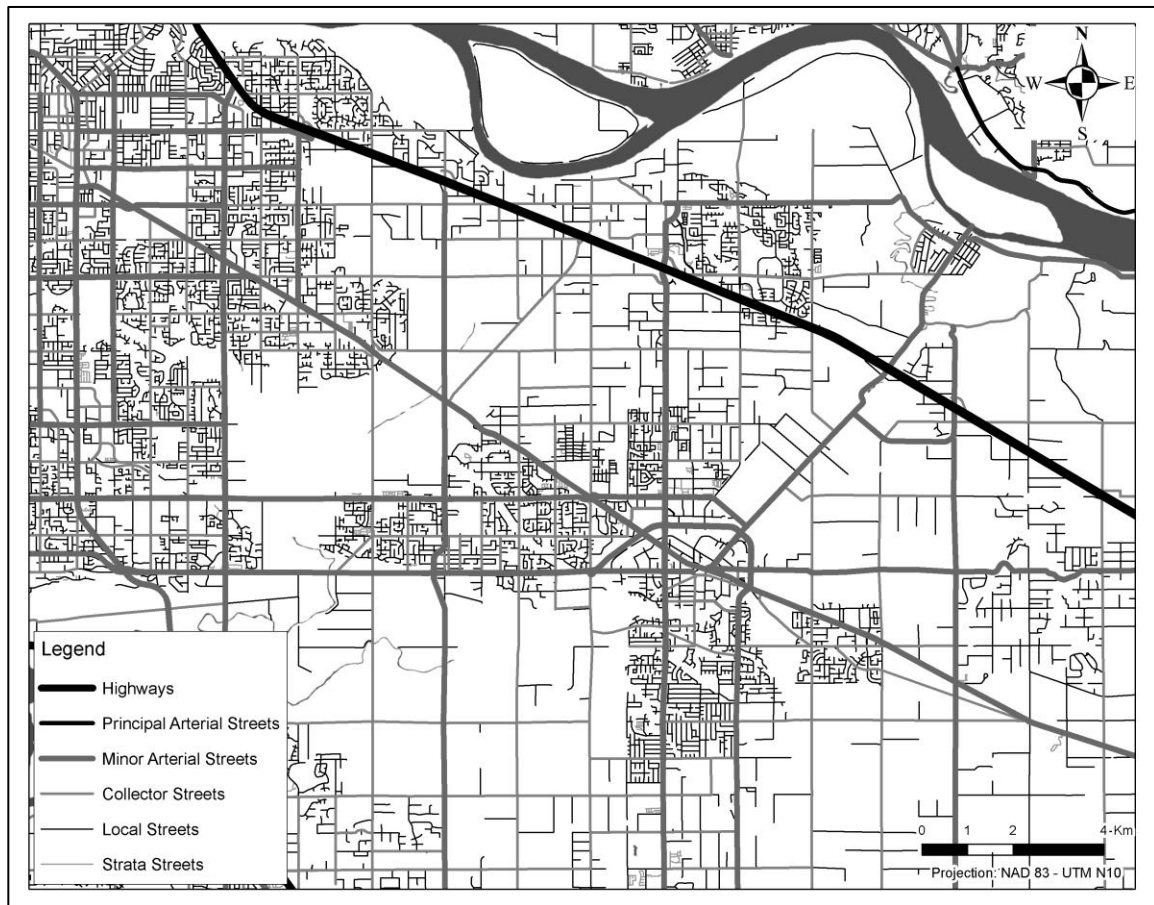
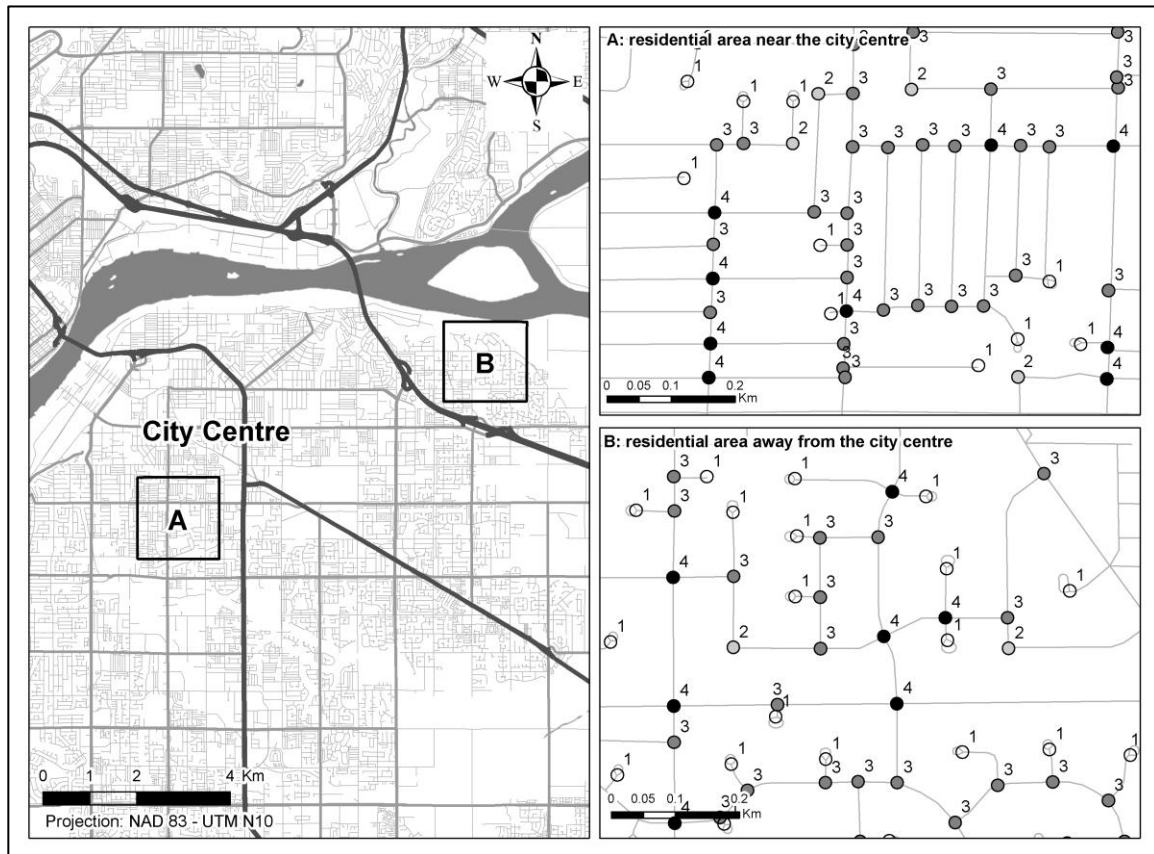


Figure 3: Categories of Street Segments

A graph contains a network of nodes and links between the nodes. Within the field of Environmental Criminology, nodes are translated into intersections and links into road segments. The degree of connectedness for an intersection depends on the number of street segments that connect to it. Figure 4 displays

how street segments closer to the city centre are more connected than those in residential areas away from the city centre.



Transit Infrastructure

The transit infrastructure forms urban morphology because it moves a large volume of people on a daily basis. In particular, the entry and exit points in this system (eg: Transit station – bus stop) are prominent in forming awareness spaces and dictating crime patterns. These systems should be seen as overlaying the street network and include bus routes and rail systems as displayed in Figure 5.

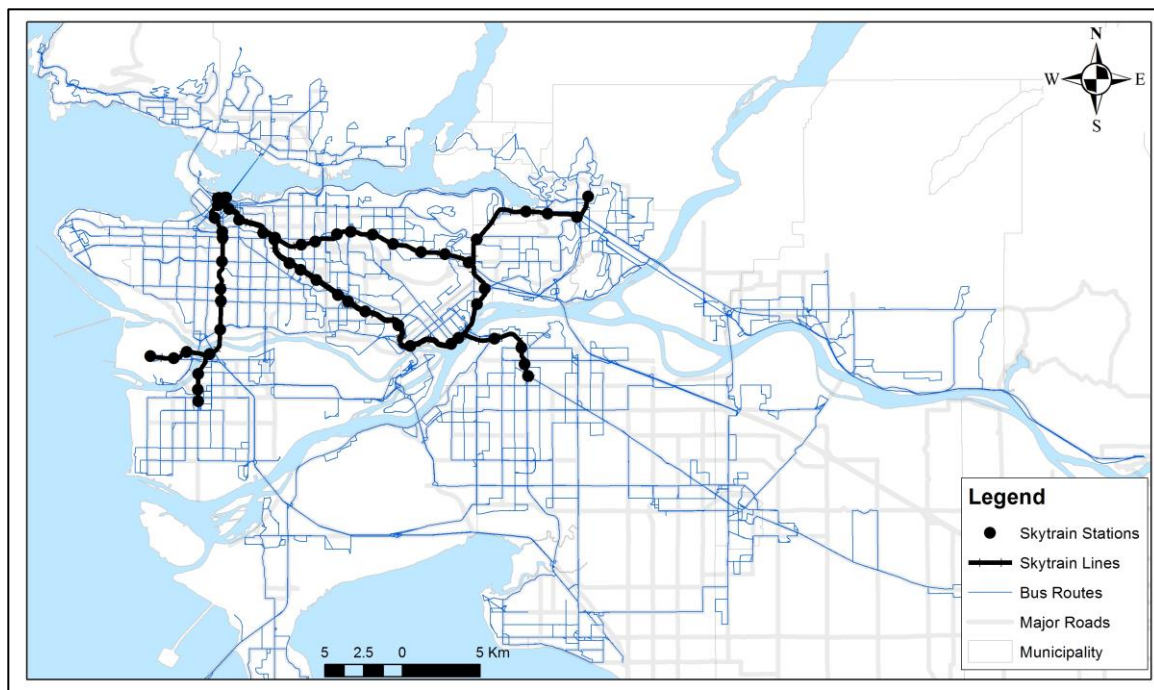


Figure 5: Metro Vancouver Skytrain Lines and Bus Routes

Many cities are engaging in green initiatives and utilizing transit systems to reduce the use of vehicles. In particular, bicycle lanes are becoming prominent structures within the cityscape. In Figure 6, designated bicycle routes in Vancouver are added to the transit structure.

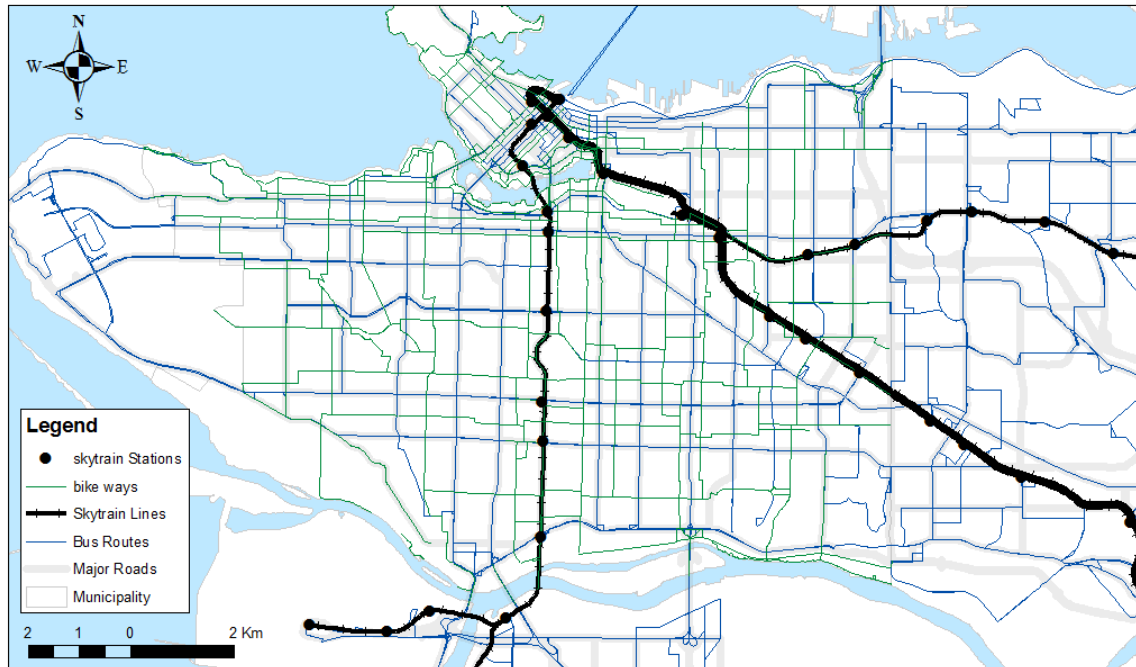


Figure 6: City of Vancouver Transit Routes: Skytrain – Bus – Bicycle

Land Uses or Use of Land

The street network and transit infrastructure are linked to land uses. For example in Metro Vancouver, high density residential is paired with mixed use to create live-work-entertainment areas adjacent to Skytrain stations. Spatial and temporal crime patterns follow land use with some types creating hot times/spots and others cool times/spots. Land use can also be used to determine activity nodes such as schools or entertainment areas that form the basis of awareness spaces. In Figure 7, 24 land use types are overlaid onto the street network. Major arteries in the city become evident through the land uses: commercial – mixed residential commercial low rise – mixed residential high rise.

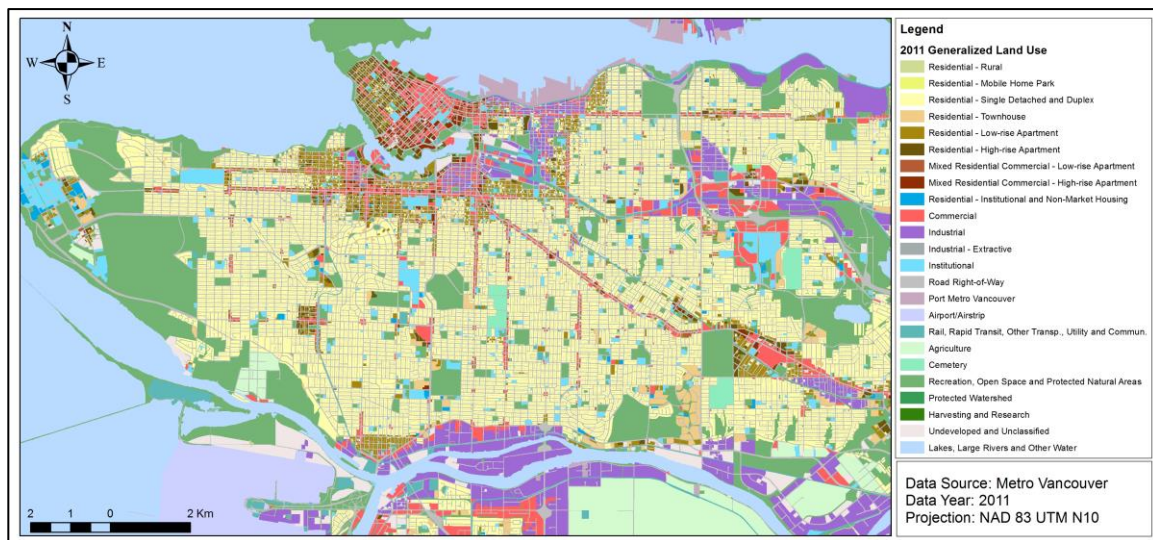


Figure 7: City of Vancouver Land Use Designation

Physical Topography

Physical topography has a strong impact on the road network and the structure of the city. Older cities were built close to waterways so goods could be transported over long distances. Mountains and hills were used as part of fortification and defense within the construction of medieval cities. Modern day cities are also influenced by physical topography with waterways creating physical edges between urban spaces, mountains creating physical limitations for the construction of large urban areas, and plains or flatter areas ideal for large urban settlements. Figure 8 displays the topography of Metro Vancouver. To the north, there are the North Shore Mountains that are part of the Pacific Range and create a definite boundary for urban growth as streets end mid range. The Pacific Ocean to the west penetrate the coast creating deep inlets that can only be traverse by bridge and roads circle the coast line to reach further inner plains where urban development can expand.

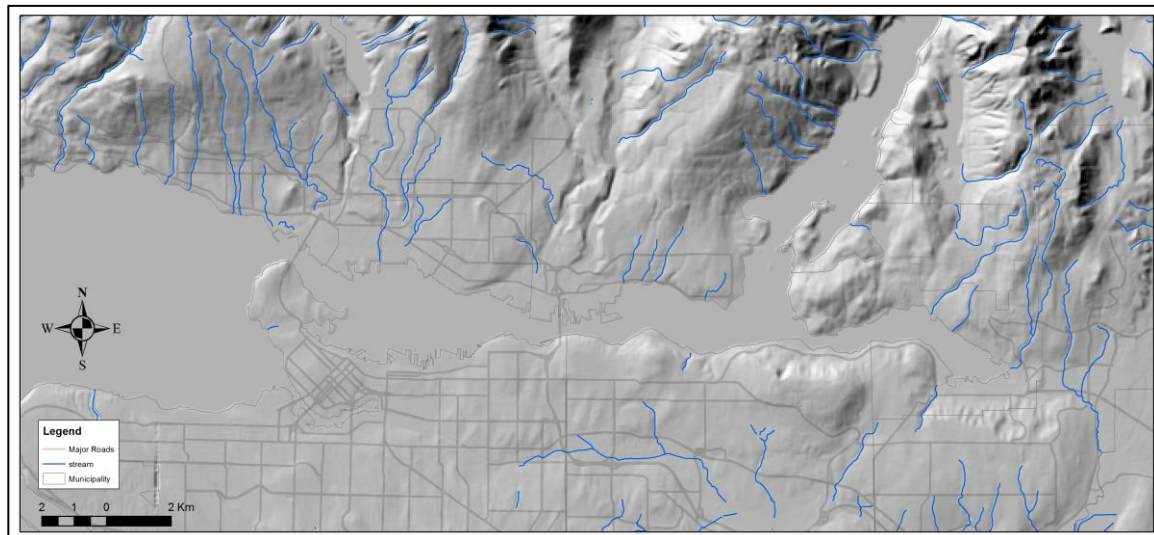


Figure 8: Topographical Visualization of Metro Vancouver

Socio-economic characteristics

Socioeconomic and population conditions are important factors in understanding patterns of crime. In particular, it is important to consider homogeneous versus heterogeneous neighbourhoods including how the boundaries of these neighbourhood connect to other ones. Some neighbourhoods are more permeable than others where individuals are less connected to each other and 'insiders' less likely to recognize 'outsiders'. As well, population density is important to consider especially in relation to land uses. In Figure 9, the population density is displayed. The downtown core of Vancouver has the land use, topography and service concentration that enabled a growth in population.

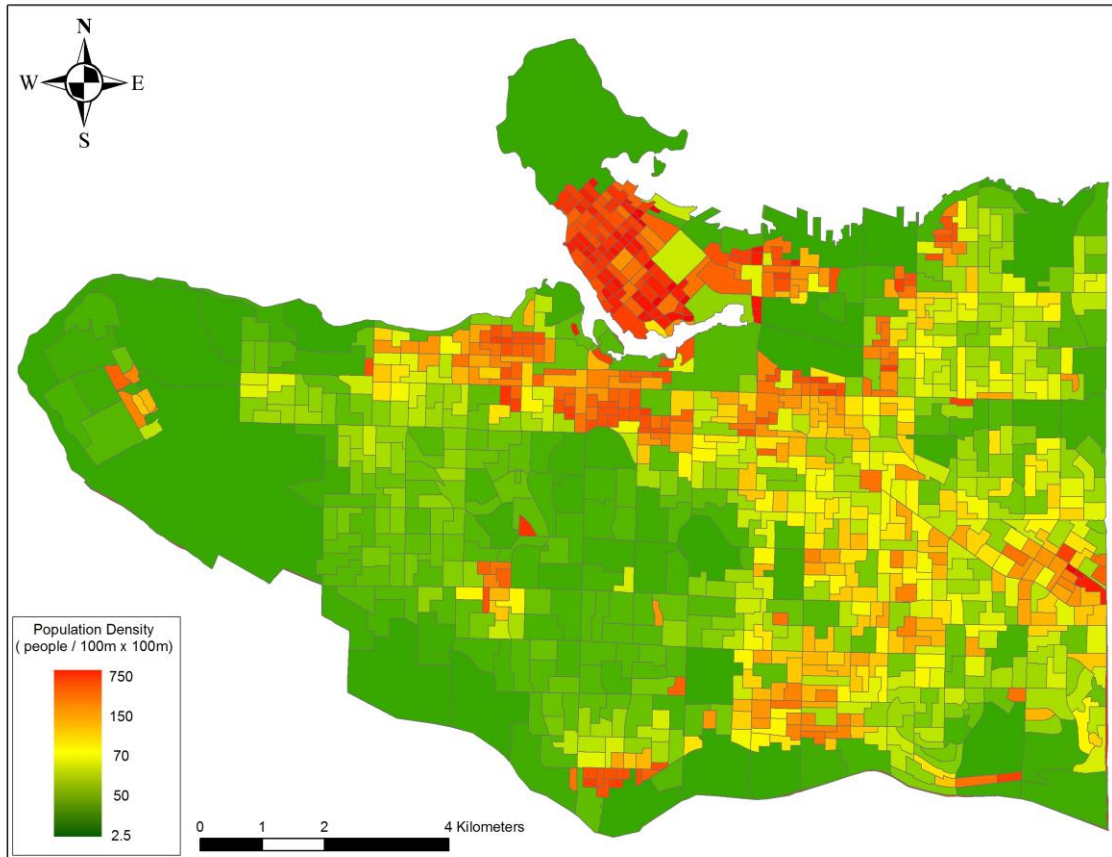


Figure 9: 2011 Vancouver Population Density 100 by 100 Meters

Crime Attractors and Generators

Within the environmental backcloth there are places that attract potential offenders – crime attractors and also places that have a high volume of people including potential offenders – crime generators. Individuals have activity spaces and it is the overlap of these activity spaces that create these generators and attractors. Certain places have a particular strong pull and can impact the offending direction of offenders throughout a city. In Figure 10, the crime density areas are created using the direction between the offender's home location and their offending location. This crime density is layer on top of the street network and the regional shopping centre acts as both a crime attractor and generator.

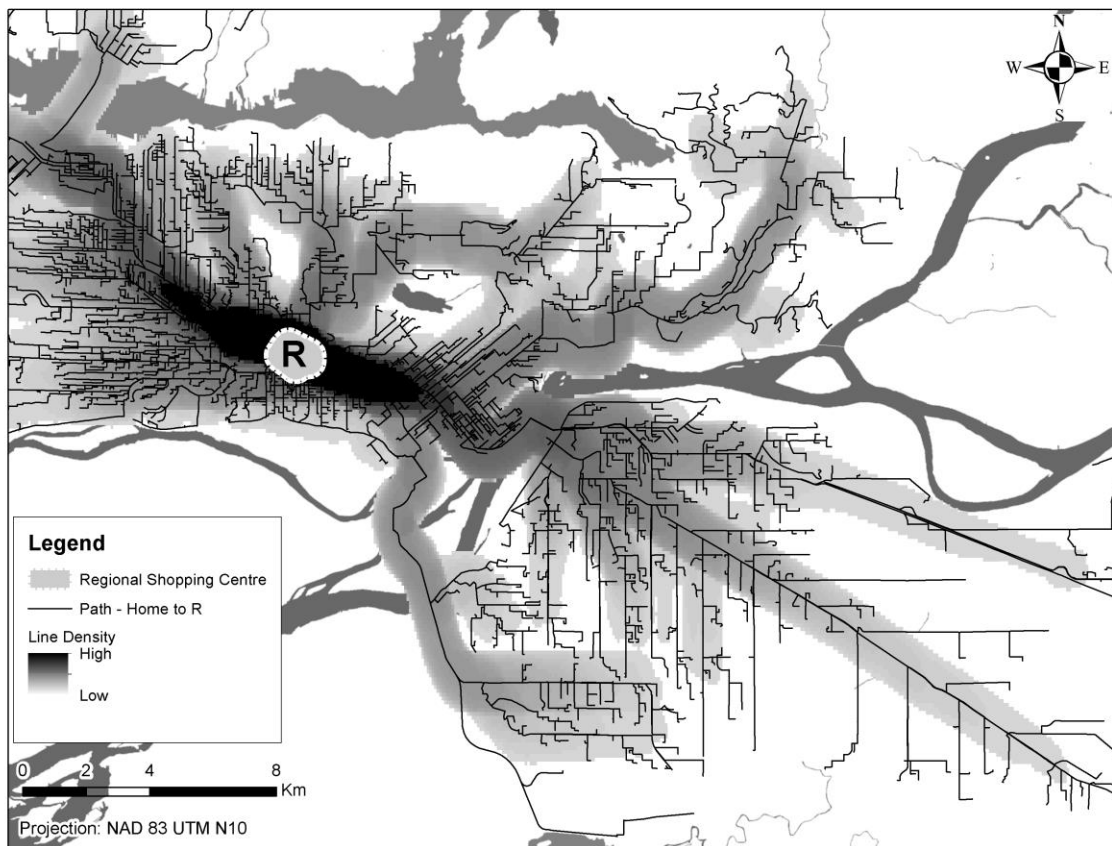


Figure 10: Regional Shopping Centres and Offender Pull

Directionality

The term directionality in geography describes an individual's orientation with their environment. Within the context of criminal offending, directionality exists between activity nodes. The path taken may not be straight or the shortest distance, but rather the path have an orientation or what is referred to as directionality. Figure 11 demonstrates how these are three paths between point A and point B – all three paths are within the awareness space between these two paths. Research on directionality has shown that offenders make a clear choice in direction and that half their offences occur within a 30 degree angle from their home location.

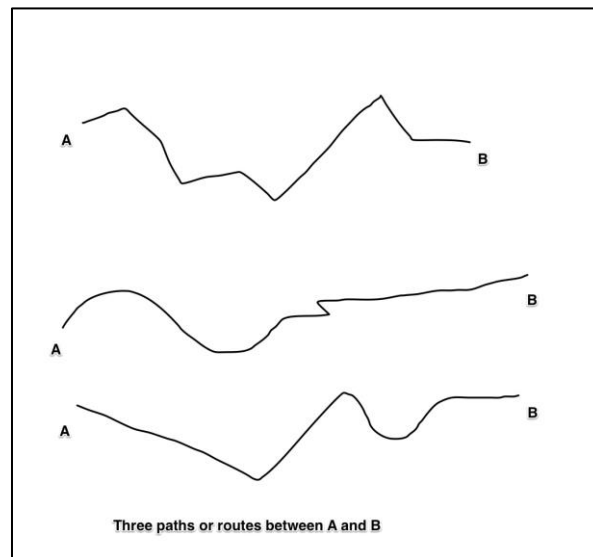


Figure 11: Different Pathways

In Figure 12, the three routes are layered onto the street network and demonstrate how three paths fall within the same degree angle from point A while remaining in a more general awareness space of the street network.

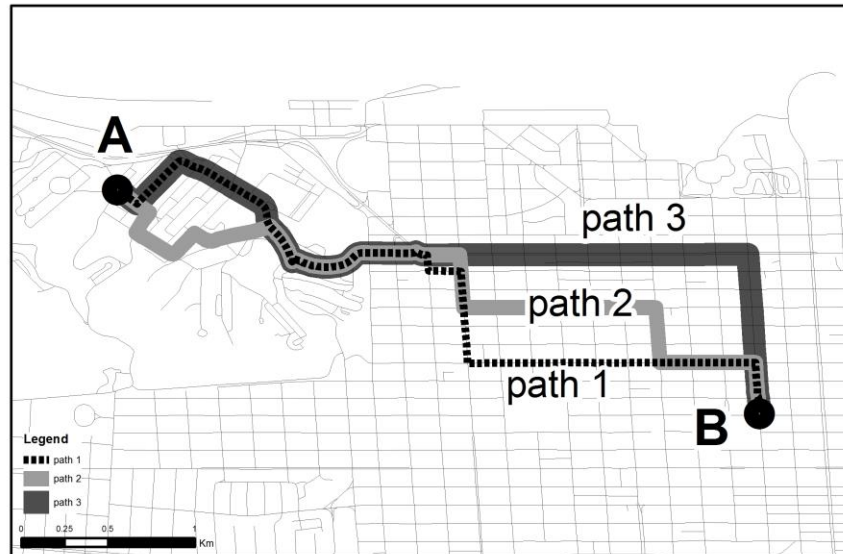


Figure 12: Pathways Displayed on a Map

A directional pull occurs with a crime attractor and offenders within an area move towards this central location. In Figure 3, the arrows represent the direction from the offender's home location to their offending location. The regional shopping centres create a distinctive offender pull and impact their directional choice.

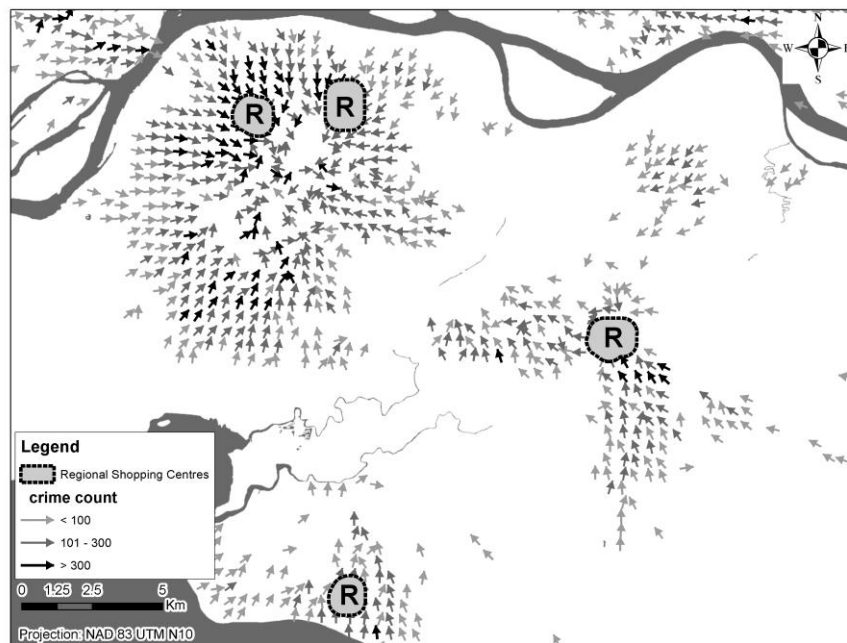


Figure 13: Shopping Areas and Directional Pull of Offenders

Catchment Areas

Catchment area is a concept borrowed from geo-marketing to describe offending patterns. Within cities there can be single or multiple attractors. Each attractor forms a catchment area for offending. When multiple attractors exist, distinct offending catchment areas can be defined by looking at offender directionality. Figure 14 displays catchment areas for a single and for multiple attractors. Figure 15 uses real offending data to demonstrate how this occurs.

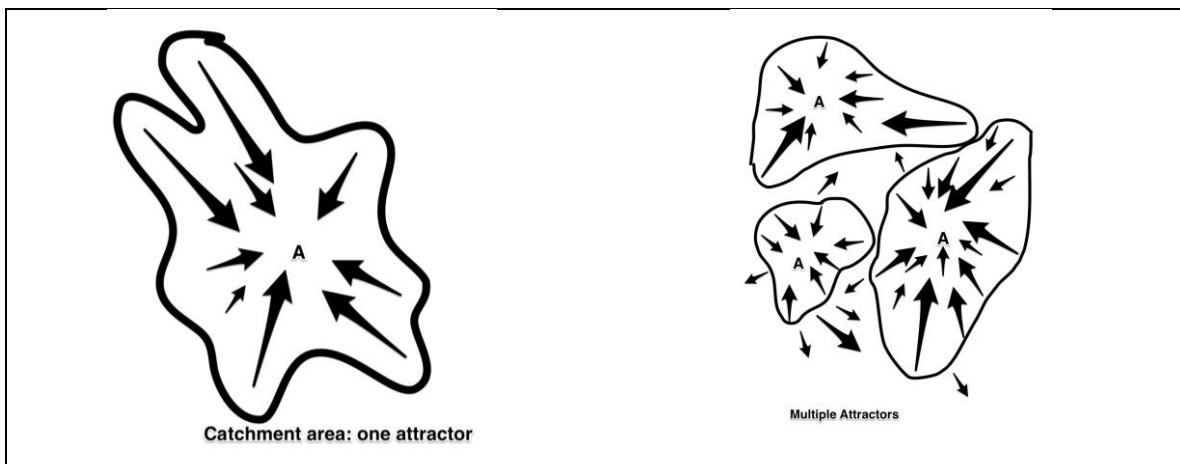


Figure 14: One Attractor and Two Attractor Diagrams

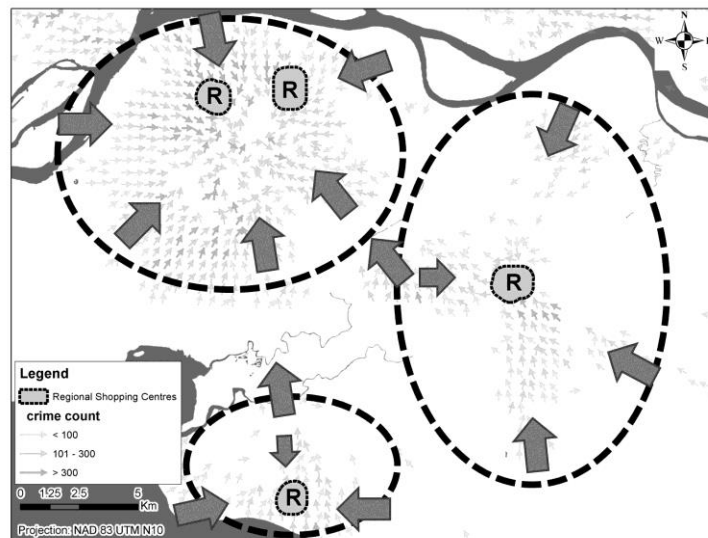


Figure 15: Crime Catchment Areas – Offender Pull

Edge Effect

There are many aspects of the environment that form perceptual or physical edges. Some edges are more permeable than others and edges are also temporal in nature. Certain edges can contain high concentrations of crime. For example, single-family residential areas that meet a different land use such as multiple residential, industrial and/or commercial are high crime edges or what is called the edge effect. In Figure 16, the single family residences are parcelled out and the 30 metre edges denoted by the black lines. Within this 30 meter edge area, crime is significantly higher.

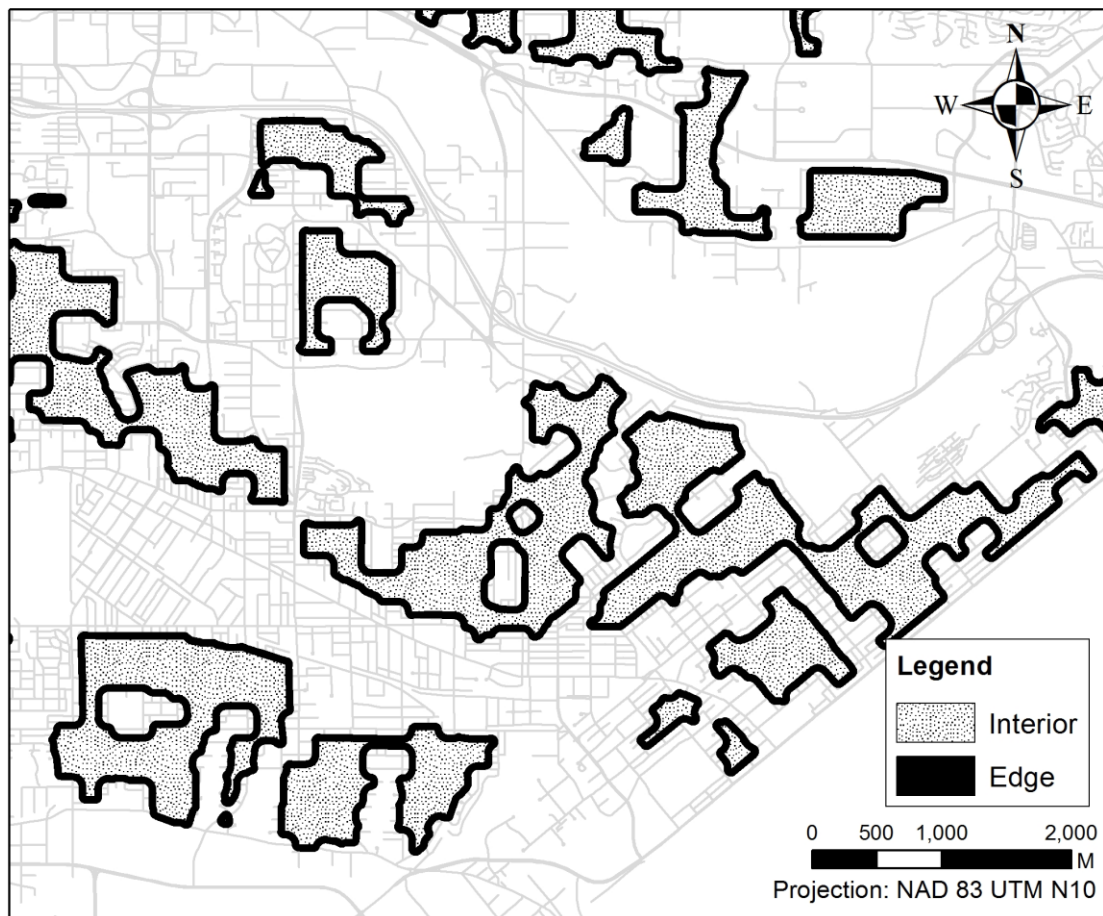


Figure 16: Edge Effect and Interior Single Family Residence

Crime Corridors – Street Profile Analysis

The term crime corridor is used to describe arterial streets that have higher levels of crime. Research on street segments indicates that certain segments consistently have more crime on them. A crime corridor is a succession of high crime street segments. Not all arterials contain high levels of crime, however some arterials are connected to the urban infrastructure in such a way that they are gateways for crime. In particular, arterials connecting to nodes where multiple types of transportation intersect such as car – public transport – walking, can become crime corridors. Figure 17 displays the street network of Vancouver and Figure 18 separates these streets into classes emphasizing arterial streets.

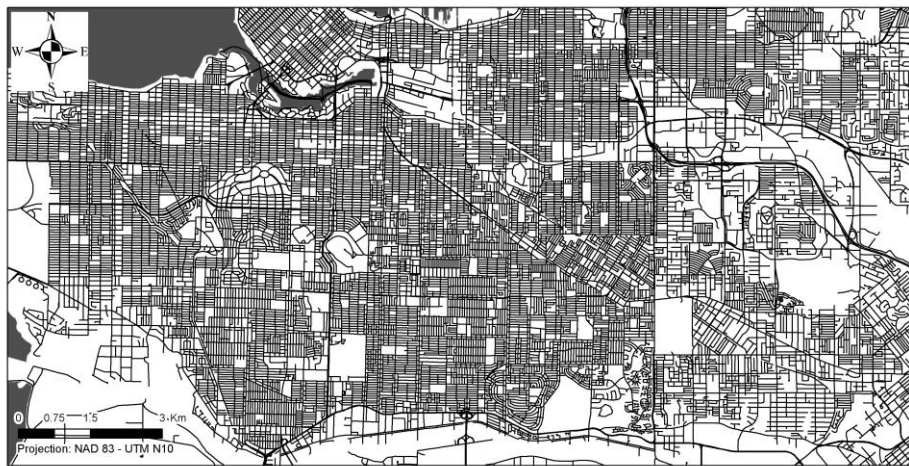


Figure 17: City of Vancouver Street Network

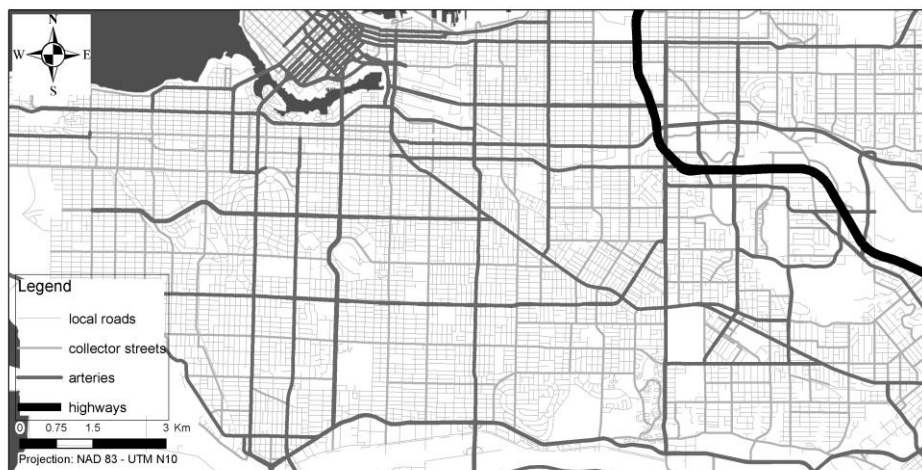


Figure 18: Arterial Corridor Streets

In Vancouver, Broadway Avenue is a crime corridor. At the eastern end of this city there is a major transit hub that connects to Skytrain lines. This is the largest transit hub in western Canada. At this hub, there is a connection to rapid transit buses that cross the city. This hub is also at the southern end of a popular pedestrian oriented street. Figure 19 shows the location of Broadway Avenue in the city of Vancouver. The street profile analysis is used to study crime corridors. Street profile analysis is a two-dimensional method that simplifies the visual representation of the crime dynamics along a street. Figure 20 displays the application of street profile analysis on Broadway Avenue.

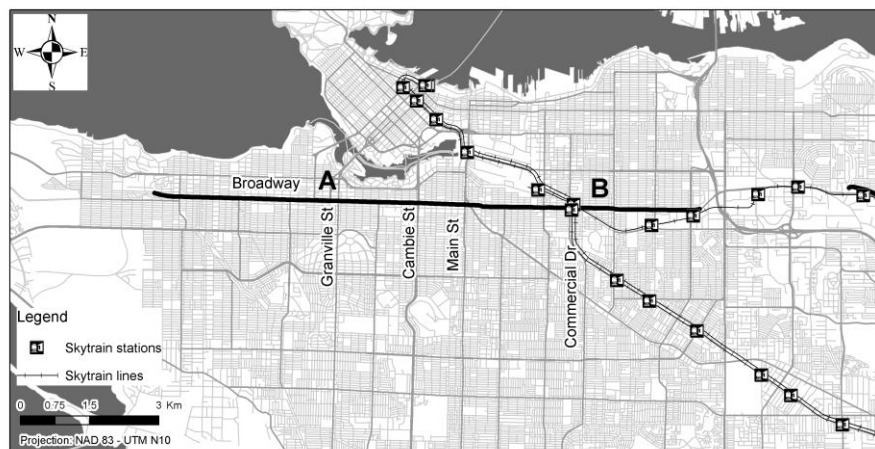


Figure 19: Broadway Avenue – City of Vancouver

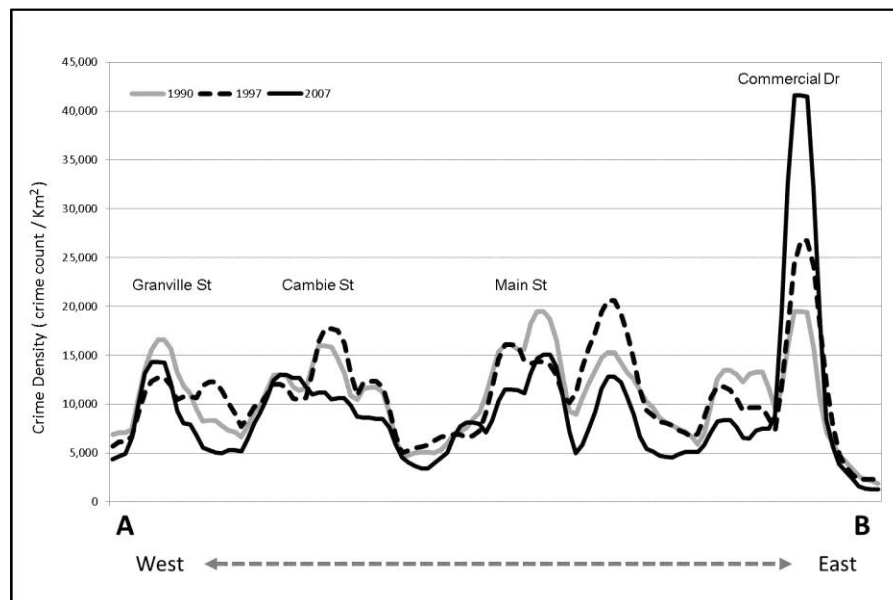


Figure 20: Street Profile Analysis – Broadway Avenue

Crime Ridges

Within a metropolitan context, crime ridges are the conglomerate effect of road networks, mass transportation structures, crime catchment areas and directionality. Metropolitan areas usually contain several town centres that are interconnected with these various transportation structures that form the crime ridges along the well-travelled routes between these places. In Figure 21 town centres are represented with the blue dots and the crime ridges with arrows between the centres.

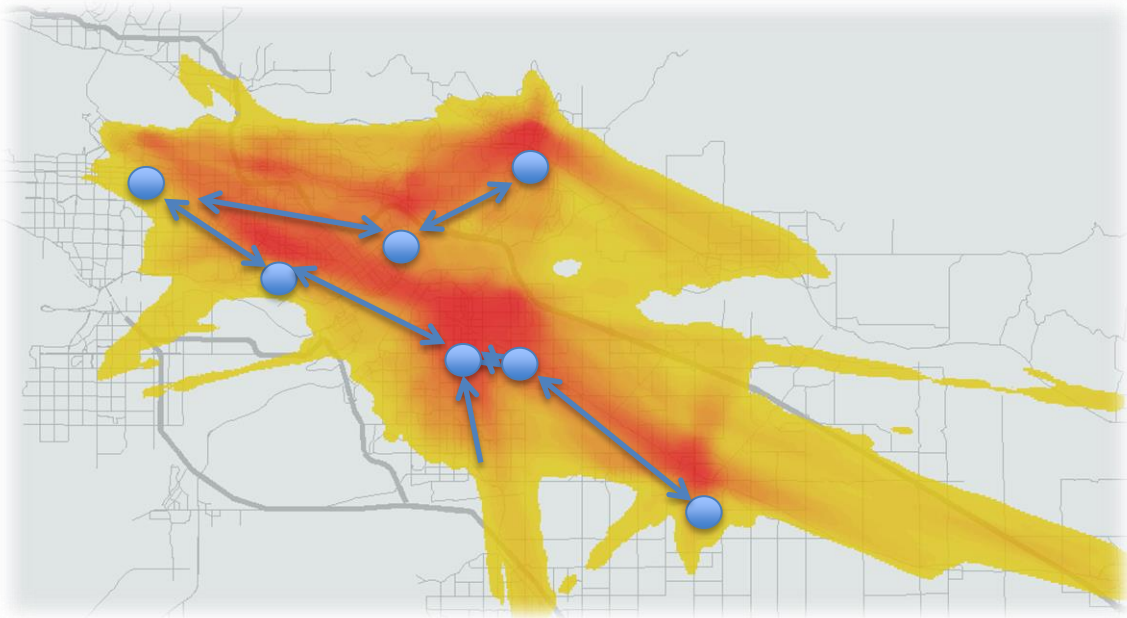


Figure 21: Crime Ridges Metro Vancouver with Town Centres

Aggregate Offender Movement

Aggregate offender movement can also be determined within the metropolitan context. In Figure 22, the offender home locations and crime locations are displayed in the aggregate using 500 by 500 rasters.

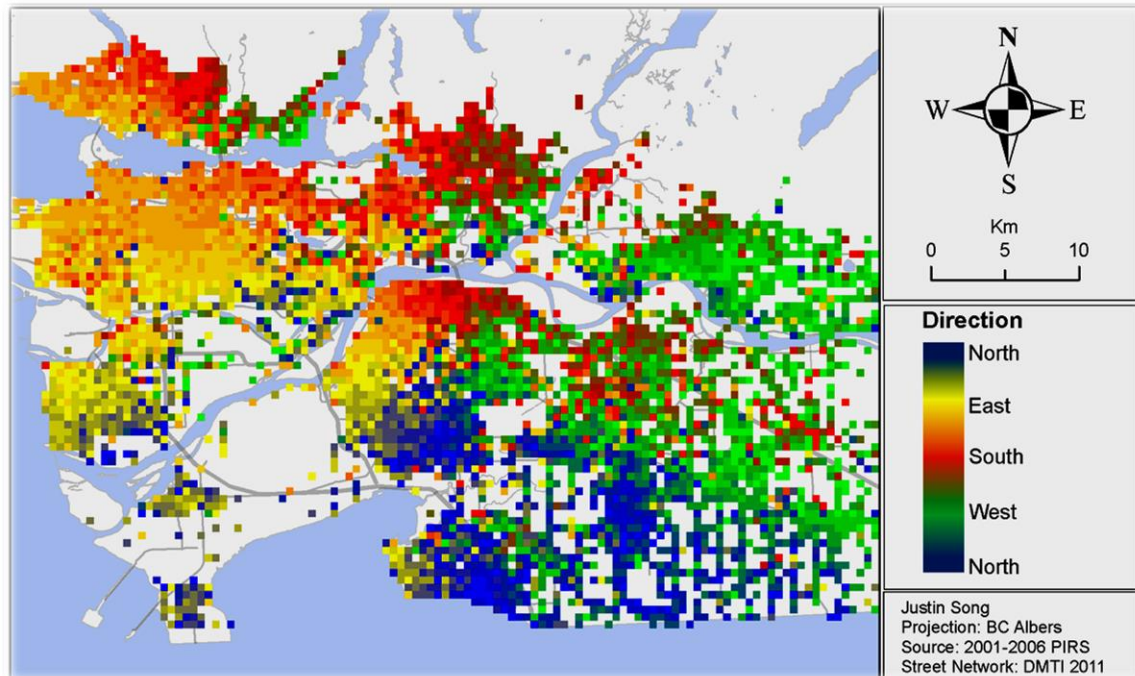


Figure 22: Aggregate Offender Movement

2.5 Dimensional Visualization

2.5 dimensional visualization is an effective way to describe aggregate crime patterns in the urban environment. This technique merges many of the concepts describe in this paper into a single visual image. Figure 23, is a 2.5 dimensional visualization of crime in the City of Surrey. In this image, the edge effect is prominent as major arterials where single family residential meets multiple and/or commercial zone contain more crime. Nodes and crime attractor also contain more crime. Crime corridors are also made obvious. This 2.5 dimensional technique work well with the other visualization techniques to provide an overall view of crime in the city.

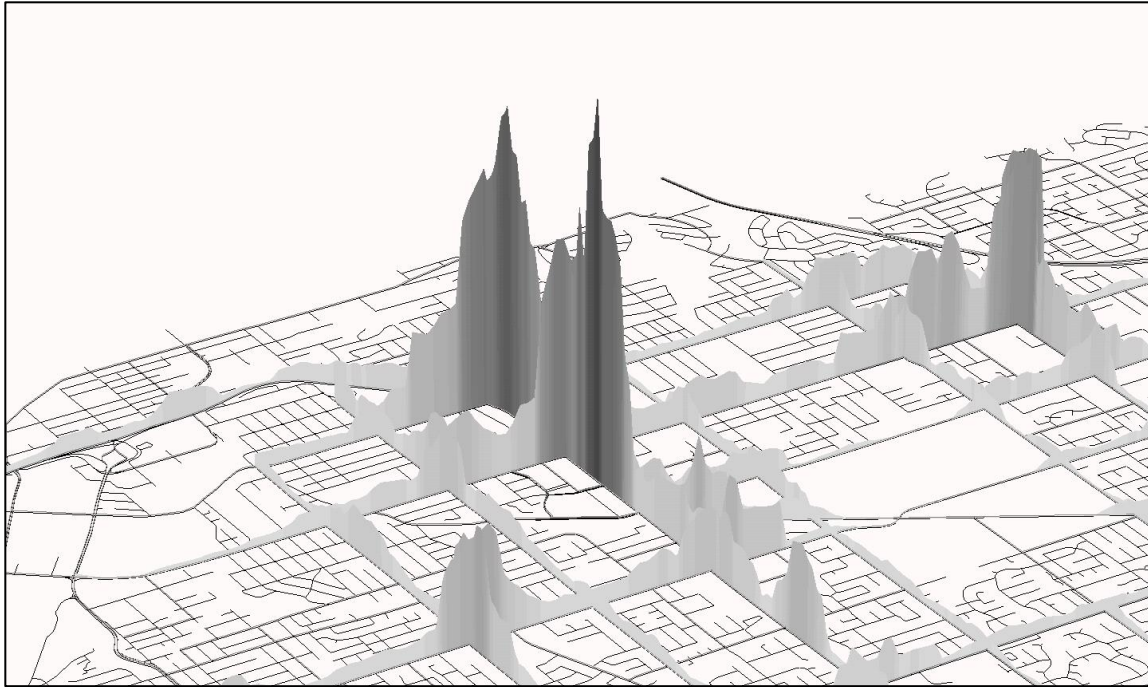


Figure 23: 2.5 Dimensional Mapping Visualization on the Street Network

Temporal Directionality

Temporal directionality is used to describe aggregate patterns of crime time of day, month or year. Research indicates that crime also patterns in time with certain times generating more crimes than other times. As well, certain places generate crime at different times than other places. For example, a bar generates more crime at closing time in the early morning hours, whereas a shopping centre generates more crime during peak daytime hours. Figure 24 shows crime at different times of the day at the intersection of Broadway Avenue and Commercial Drive. This intersection contains the largest transit hub in western Canada. The crime patterns vary throughout the day displaying the temporal directionality created by mass transportation.

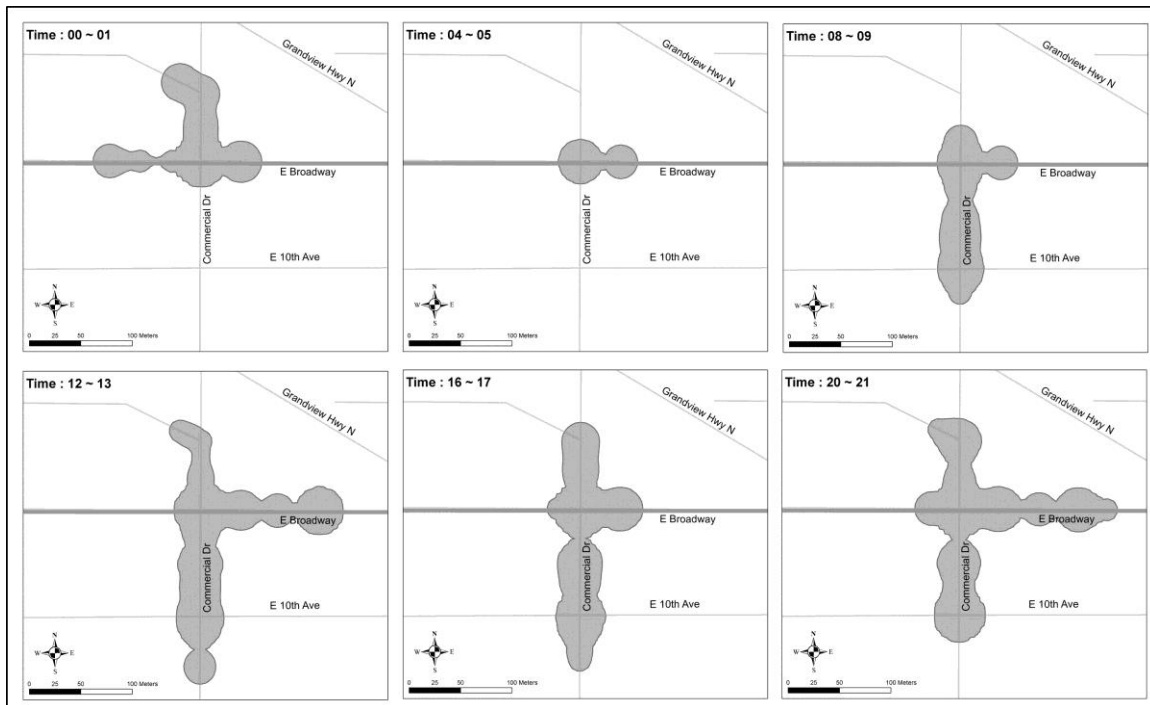


Figure 24: Temporal Directionality at a Mass Transportation Hub

Temporal Density

Crime density on road segments varies by time of day. Figure 25 is a 24 hr analysis of crime on Vancouver streets. Crime occurs on very few city streets between 3 and 6 AM with less than five streets containing over 100 crimes per year during this time period.

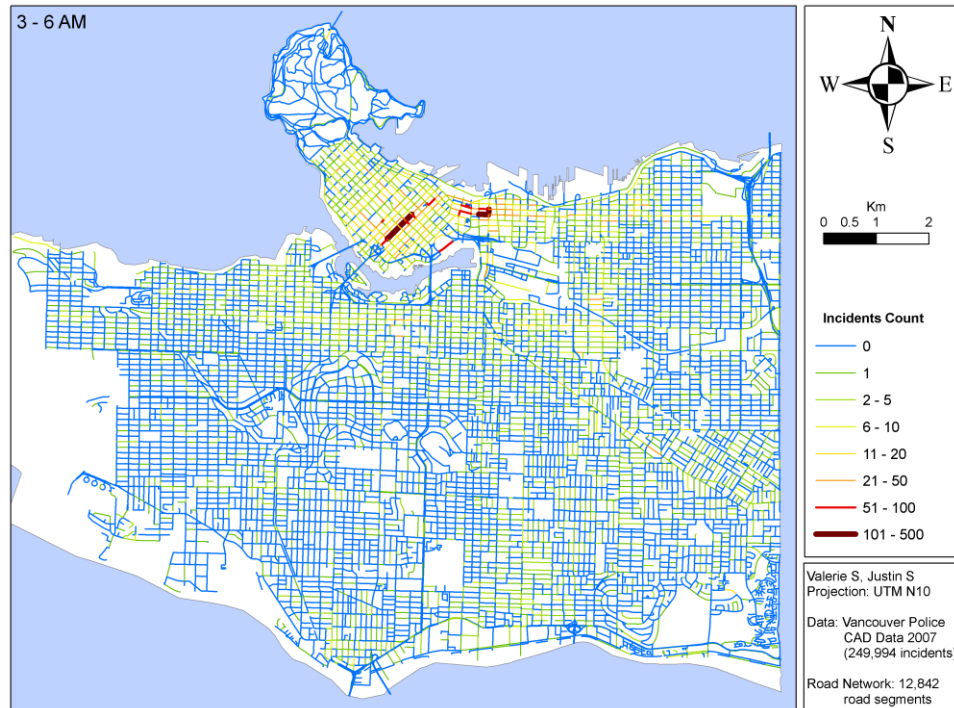


Figure 24: 24hr Analysis Vancouver Road Segments